JC17 Rec'd PCT/PTO 28 JUN 2001

FORM PTO-1390 (REV. 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER **10191/1903**
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/869507

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/DE00/03397	**27 September 2000 (27.09.00)**	**28 October 1999 (28.10.99)**

TITLE OF INVENTION
DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE

APPLICANT(S) FOR DO/EO/US
WINTER, Klaus; WINNER, Hermann; MARCHTHALER, Reiner; LUEDER, Jens; and LEINBAUM, Stephan

Applicants herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have. been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)) (unsigned).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☒ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report (translated), and PCT/RO/101.

EXPRESS MAIL NO.: EL244504170

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U.S. APPLICATION NO. (if known, see 37 C.F.R.1.5) 09/869507	INTERNATIONAL APPLICATION NO PCT/DE00/03397	ATTORNEY'S DOCKET NUMBER 10191/1903

17. ☒ The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):

Search Report has been prepared by the EUROPEAN PATENT OFFICE or JPO $860.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) $690.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $710.00

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,000.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

				CALCULATIONS	PTO USE ONLY
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 860	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	12 - 20 =	0	X $18.00	$ 0	
Independent Claims	2 - 3 =	0	X $80.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $270.00	$	
TOTAL OF ABOVE CALCULATIONS =				$ 860	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 860	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 860	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$ 860	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $________ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of **$860.00** to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

By: [handwritten signature] (Reg. No. 41,172)

[signature]
SIGNATURE

SEND ALL CORRESPONDENCE TO:
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CUSTOMER NO. 26646

DATE 6/28/01

09/869507

JC13 Rec'd PCT/PTO 2 8 JUN 2001

[10191/1903]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	WINTER et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner
for Patents
Washington, D.C. 20231
Box Patent Application

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of the claims, first line, change "What is claimed is:" to: --What Is Claimed Is:--.

Please cancel original claims 1 to 11, without prejudice, in the underlying PCT Application No. PCT/DE00/03397.

EL244504170

Please add the following new claims:

12. (New) A distance sensor for a motor vehicle, comprising:

a sensor element for performing one of:

transmitting one of microwaves and light, and

receiving an echo signal reflected by a target object;

a control system including an arrangement for, during travel on a straight road, using an algorithm to ascertain a misalignment angle of the sensor element with respect to a center axis of the motor vehicle from transmitted and received rays, the arrangement correcting a continuing angle measurement in accordance with the misalignment angle; and

an arrangement for compensating for a trajectory for a curvature travel along a curve.

13. (New) The distance sensor according to claim 12, wherein:

the arrangement for compensating includes a yaw rate sensor that produces a signal capable of correcting the trajectory for the curvature travel.

14. (New) The distance sensor according to claim 12, wherein:

the control system determines a quality indicator of the trajectory from ascertained misalignment angles of individual trajectories in accordance with an adaptive long-term filter.

15. (New) The distance sensor according to claim 14, wherein:

the quality indicator is calculated from a correlation value of a regression analysis of at least one of the curve, a number of measured points, a trajectory length, and an object speed.

16. (New) The distance sensor according to claim 14, wherein:

the adaptive long-term filter is a noise-optimized linear filter.

17. (New) The distance sensor according to claim 16, wherein:

the noise-optimized linear filter is a Kalman filter.

18. (New) The distance sensor according to claim 14, wherein:

the adaptive long-term filter is a nonlinear filter in which a weighting of individual measured values results from a quality appraisal.

19. (New) The distance sensor according to claim 13, wherein:

when a positioning of the sensor element occurs outside the center axis of the motor vehicle, the control system ascertains the misalignment angle with respect to the center axis.

20. (New) The distance sensor according to claim 19, wherein:

the control system performs a weighting of the misalignment angle as one of a first process involving a function of weighted average values of the yaw rate sensor and a second process involving a displacement of the center axis.

21. (New) The distance sensor according to claim 20, wherein:

the weighting occurs on the weighted average values of the first process and the second process.

22. (New) The distance sensor according to claim 20, wherein:

quality numbers for the misalignment angle are developed from weighting factors according to the formula:

$$d_{alpha} = G1(q\_traj) \star d_{alpha\_traj} + G2(q\_obj) \star d_{alpha\_obj}.$$

where d_{alpha} is a currently valid misalignment angle from the center axis, G1(q_traj) and G2(q obj) are weighted average values from values of one of the yaw rate sensor and an average displacement, and d_{alpha_traj} and d_{alpha_obj} are associated angles.

23. (New) A speed regulator, comprising:

a distance sensor for a motor vehicle, the distance sensor including:

a sensor element for performing one of:

transmitting one of microwaves and light, and

receiving an echo signal reflected by a target object;

a control system including an arrangement for, during travel on a straight road, using an algorithm to ascertain a misalignment angle of the sensor element with respect to a center axis of the motor vehicle from transmitted and received rays, the arrangement correcting a continuing angle measurement in accordance with the misalignment angle; and

an arrangement for compensating for a trajectory for a curvature travel along a curve, wherein:

the sensor element is mounted on at least one of a front and a rear area of the motor vehicle.

Remarks

This Preliminary Amendment cancels original claims 1 to 11, without prejudice, in the underlying PCT Application No. PCT/DE00/03397. The Preliminary Amendment also adds new claims 12-23. The new claims conform the claims to U.S. Patent and Trademark Office rules and do not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/DE00/03397 includes an International Search Report, dated March 16, 2001, a copy of which is submitted herewith.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

By: Do Magnt

Dated: 6/28/01

By: Richard L. Mayer

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DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE.

Field Of The Invention

The present invention relates to a distance sensor for a vehicle having a sensor for transmitting microwaves or light, or for receiving an echo signal reflected by a target object.

Background Information

In the case of speed regulators having a distance sensor (Adaptive Cruise Control, ACC) adapting travel speed of a motor vehicle to slower vehicles traveling ahead, when these are detected by the distance sensor, is already known. However, the distance sensor has a limited detection range, and thus can only detect such vehicles as are located in the prospective course range of the following vehicle. A misalignment of this detection range, which can occur either during installation on the vehicle or during operation, has the effect, however, that the longitudinal axis of the distance sensor relatively to the nominal alignment (center line of the vehicle) has a systematic angle of deviation. This can have the result that this misalignment, for example, leads to a faulty lane assignment of a detected radar object on the path of motion of the motor vehicle (trajectory), that is, to a vehicle being followed or coming in the opposite direction, and that thereby an undesired reaction of the speed regulator can take place.

A compensating device is known, for example, from German Published Patent Application No. 197 46 524, for compensating for the installation tolerances of a distance sensor in a vehicle, in which the installation tolerances of a distance sensor are compensated. Using an electronic evaluation device, current object distances and a current object angle are measured during travel, for detected objects relatively to the vehicle axis. In this connection, the

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misalignment angle to the current target object is determined by forming an average value of many measurements. It is true, though, that this average value formation functions satisfactorily only if the vehicle can follow the target object, a second vehicle traveling ahead, on a sufficiently long straight path, so that frequent measurements to the target object can be carried out. In the case of curves in the road or, also, uphill and down dale travel with changing angle of altitude, this method fails.

On the other hand, in the case of the device for calculating and correcting a misalignment angle for a distance sensor according to European Published Patent Application No. 0 782 008 the angle of deviation from the center line is described, using a regression method. To do this, the angle is measured in each measurement cycle as a function of the distance from moving, or better still, from fixed radar objects. In particular in dense traffic, however, there are not enough suitable objects within sight range of the sensor, so that not enough measured values are available. Thus, each method has the disadvantage that the availability of measured values depends on the travel situation or the traffic situation, as the case may be.

Summary Of The Invention

By comparison, the distance sensor or the speed regulator according to the present invention has the advantage that the reliability of the misalignment identification increases by the combination of a plurality of methods for determing a misalignment angle.

A particular advantage as compared to the known related art is considered also to be that the measurements for the misalignment angle can be carried out, not only on a straight travel path, but also along a curve. More measured values result from this, which, in particular, also favor the formation of the average value.

It is especially advantageous that a yaw rate sensor is provided as a further instrument, whose signals can be used for correcting trajectory curves. Since the yaw rate sensor detects the rotary motion of the vehicle about the vertical axis, it thereby also detects, in consideration of the driving speed, the bend in the travel path, or the curve, so that, from these data, appropriate angle calculations with respect to a vehicle driving ahead, which has been detected by the sensor, can be carried out The bend of a trajectory, in this connection, is

looked upon as being the reciprocal value of the radius of the path, (in English: the curvature).

With the aid of adaptive long-term filtering, quality indicators of the trajectory are ascertained from the ascertained misalignment angles of individual trajectories. With the aid of the quality indicators of the trajectory, reliability of the angle measurement is advantageously improved. In this case, for example, the determination of the quality indicators is made from the correlation value of a regression analysis of the curvature, the number of measured values, the length of the trajectory and/or the speed of the object. Since these parameters are relatively simple to measure, this also makes possible a simple calculation of the quality indicator.

For the application of adaptive long-term filtering of the ascertained misalignment angle from individual trajectories, for example, a noise-optimized, linear, adaptive filter (e.g. a Kalman filter) is suitable, or a nonlinear filter in which the weighting of the individual measured values from the quality valuation is based on the quality indicators of the trajectory.

A nonlinear filter can also be used as a suitable adaptive long-term filter, in which the weighting of the individual measured values is done from the quality appraisal.

It is regarded as a special advantage that, with a positioning of the sensor outside the center line of the motor vehicle, the control system ascertains the misalignment angle with respect to the center line of the motor vehicle. That also causes the lateral angle arising from the center displacement of the sensor to be compensated for.

It is also favorable that the ascertainment of the misalignment angle is weighted either as a function of the weighted average values of the yaw rate sensor or of the displacement from the center line. This yields an improvement in the signal quality, which improves the robustness of the method for determining the misalignment angle, depending on the availability of the individual systems, since almost always at least one of the two methods receives suitable input data. Thereby one method advantageously compensates for the weaknesses of the other method.

By weighting the averaged mean values of the two individual methods, one obtains an improved signal quality.

Brief Description Of The Drawings

Figure 1 shows a first diagram with angle representations of ray paths.
Figure 2 shows a block diagram of a distance sensor.
Figure 3 shows a second diagram.

Detailed Description

Figure 1 shows two motor vehicles 5, 6 which are traveling along on a road one behind the other at a distance d, the assumption being that motor vehicle 5 is behind motor vehicle 6. Furthermore, for reasons of clarity, only the middle rays of a sensor 2 are illustrated, not the entire radiation in the radiation range. It is also assumed in the exemplary embodiment that, in a first embodiment variant, a sensor 2 is mounted centrically on the front face of motor vehicle 5. It is aligned in such a way that its middle ray detects the rear end of motor vehicle 6 driving ahead. On account of an assumed misalignment, the transmitted ray does not hit the rear end along the center line of motor vehicle 5, but rather displaced by an average angle alpha_sensor. For the sake of completeness, let it be mentioned that this reflected ray is received by a corresponding receiving device of sensor 2 and evaluated. Such an evaluation method is known, for example, from German Published Patent Application No. 197 46 524. In the exemplary embodiment according to the present invention, the sensor is not positioned centrically but laterally displaced by a distance y_{radar}. With this sensor 2, now, the central ray b hits the projected center line of motor vehicle 5 at the rear end of target object 6 at an angle alpha_vehicle. From this positioning displaced from the center by the distance y_{radar}, and the distance d to vehicle 6 driving ahead, an angle can now be determined according to the equation

$$\text{alpha\_vehicle} = \text{alpha\_sensor} + y_{radar}/d.$$

This angle alpha_vehicle is ascertained by repeated measurements during the trip and suitable long-term filtering. Using this systematic deviation, the angle measurement of sensor 2 can be

corrected.

Carried out principally on a straight stretch of road, this method of compensating the misalignment angle by averaging the current target object angle over a plurality of measurements is less applicable in curves of the road, since there, the target "vehicle 6, driving ahead" is constantly changing the relative vehicle position with respect to sensor 2, because of the radius of curvature. To compensate for the error caused by the radius of curvature of the road, a yaw rate sensor 3 is provided on motor vehicle 5 to detect the change of direction of motor vehicle 5 about its vertical axis. Using the normalized signal from yaw rate sensor 3 and the angle alpha_vehicle, the result is an average deviation of the curvature-corrected angle according to the formula,

$$d_{alpha\_object} = \text{average value}(\text{alpha\_vehicle} - d^2 \star \text{yaw rate}/(2 \star \text{vehicle speed})),$$

where d_{alpha_object} corresponds to the corrected angle and the yaw rate corresponds to the signal of yaw rate sensor 3.

The averaging is to be carried out by a long-term low-pass filter. Furthermore, depending on the frequency of the averaging, for the magnitude d_{alpha_object} a quality value q_{object} can be given for the reliability of the angle. Since a curve 11 in a road can be set into a plurality of trajectories, there is a further possibility, when determining the misalignment angle, of applying a regression method known per se, as described, for instance, in European Published Patent Application No. 0 782 008. According to the present invention, as shown in Figure 3, in dependence on the distance to a moving, or better still, standing target object 10, as, for example, a crash barrier part or a post, angles w1 or w2 respectively, depending on position A or B of vehicle 5, are measured in curve 11. From the distance d(ti) or d(tj) at point in time ti (position A) or tj (position B) of vehicle 5, for instance, to standing target 10, a lateral displacement y(ti) or y(tj) can be calculated by simple trigonometrical conversion. In contrast to the known method, this advantageously yields additional measuring points within sensor 2, for travel in a curve. It is therefore proposed by the present invention also to combine this method of regression analysis of trajectories with yaw rate signal 3, in order to compensate for the trajectory curvatures. The measured values thus obtained are averaged by adaptive

long-term filtering of the ascertained misalignment angles of single trajectories. A noise-optimized, linear adaptive filter, for example a Kalman filter, can be used as the suitable filter. Alternatively, a nonlinear filter can also be used, in which the weighting of the individual measured value is founded on the quality assessment, which is based on quality indicators of the trajectory. The quality indicators are formed, for instance, from the correlation value of the regression analysis, from the curvature, number of measured points, trajectory length and object speed.

As a result, a sliding long-term filtered misalignment angle d_{alpha_traj} or a quality value q_traj is ascertained for the reliability of the angle, or rather is updated with each analyzed trajectory.

Since this second method also does not always yield suitable trajectories, particularly in heavy columnar traffic, in an alternative solution both approaches are advantageously linked to each other. Depending on the reliability of the individual methods, the weightings of the approaches can be varied statically or dynamically. The linking of the two approaches takes place via a weighted average value of both individual methods. The weights are determined from the quality numbers:

$$d_{alpha} = G1\ (q\_traj)\star d_{alpha\_traj} + G2(q\_obj)\star d_{alpha\_obj}.$$

where G1(q_traj) and G2(q_obj) are the weights from the quality numbers. In this respect, Q_traj and q_obj form the quality numbers Qi.

By the introduction of quality numbers Qi for each method, with a decrease in Qi in case no input variable is available for the method in the current cycle, and an increase in case input variables are available, a simple possibility of selection was found as to which of the two methods is delivering, at the moment, the more reliable statement concerning the current angle measurement. Besides the improvement of the signal quality by the combination, the robustness of the methods increases also, since almost always at least one of the two methods contains suitable input data, that means, that one method compensates for the weaknesses of the other method.

Figure 2 shows a block diagram of distance sensor 10, in which control system 1 is connected

to sensor 2 and yaw rate sensor 3. There is also provided a compensation device for angle measurement 4, in which, among other things, the calculation of the angles, among other things, is carried out. The above-named calculations are preferably made with a program that is run by the microcomputer of control system 1.

Abstract Of The Disclosure

A distance sensor having a sensor for a motor vehicle in which an arrangement is provided by which gnment angles and trajectory curvatures can be compensated for during travel not only on a straight road but also along curves. In a sensor mounted displaced from the center line of the vehicle, an angle (alpha_sensor) is measured which cuts the projected center line of the motor vehicle at the target object, a vehicle driving ahead. By the additional use of a yaw rate sensor, curve curvatures of the road are also compensated for, so that angle and distance measurement can also be made along curves.

09/869507
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[10191/1903]

DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE.

Field Of The Invention

The present invention relates to a distance sensor for a vehicle having a sensor for transmitting microwaves or light, or for receiving an echo signal reflected by a target object.

Background Information

[The present invention starts from a distance sensor for a vehicle having a sensor for transmitting microwaves or light, or for receiving an echo signal reflected by a target object, according to the species of the main claim.] In the case of speed regulators having a distance sensor (Adaptive Cruise Control, ACC) adapting travel speed of a motor vehicle to slower vehicles traveling ahead, when these are detected by the distance sensor, is already known. However, the distance sensor has a limited detection range, and thus can only detect such vehicles as are located in the prospective course range of the following vehicle. A misalignment of this detection range, which can occur either during installation on the vehicle or during operation, has the effect, however, that the longitudinal axis of the distance sensor relatively to the nominal alignment (center line of the vehicle) has a systematic angle of deviation. This can have the result that this misalignment, for example, leads to a faulty lane assignment of a detected radar object on the path of motion of the motor vehicle (trajectory), that is, to a vehicle being followed or coming in the opposite direction, and that thereby an undesired reaction of the speed regulator can take place.

A compensating device is known, for example, from German Published Patent Application No. 197 46 524 [A1], for compensating for the installation tolerances of a distance sensor in a vehicle, in which the installation tolerances of a distance sensor are compensated. Using an

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electronic evaluation device, current object distances and a current object angle are measured during travel, for detected objects relatively to the vehicle axis. In this connection, the misalignment angle to the current target object is determined by forming an average value of many measurements. It is true, though, that this average value formation functions satisfactorily only if the vehicle can follow the target object, a second vehicle traveling ahead, on a sufficiently long straight path, so that frequent measurements to the target object can be carried out. In the case of curves in the road or, also, uphill and down dale travel with changing angle of altitude, this method fails.

On the other hand, in the case of the device for calculating and correcting a misalignment angle for a distance sensor according to European Published Patent Application No. 0 782 008 [A2] the angle of deviation from the center line is described, using a regression method. To do this, the angle is measured in each measurement cycle as a function of the distance from moving, or better still, from fixed radar objects. In particular in dense traffic, however, there are not enough suitable objects within sight range of the sensor, so that not enough measured values are available. Thus, each method has the disadvantage that the availability of measured values depends on the travel situation or the traffic situation, as the case may be.

Summary [of the] Of The Invention

By comparison, the distance sensor or the speed regulator according to the present invention [or the speed regulator according to independent Claims 1 and 11, respectively,] has the advantage that the reliability of the misalignment identification increases by the combination of a plurality of methods for determing a misalignment angle.

A particular advantage as compared to the known related art is considered also to be that the measurements for the misalignment angle can be carried out, not only on a straight travel path, but also along a curve. More measured values result from this, which, in particular, also favor the formation of the average value.

[As a result of the measures specified in the dependent claims, advantageous further refinements and improvements of the method indicated in the main claim are possible.] It is especially advantageous that a yaw rate sensor is provided as a further instrument, whose

signals can be used for correcting trajectory curves. Since the yaw rate sensor detects the rotary motion of the vehicle about the vertical axis, it thereby also detects, in consideration of the driving speed, the bend in the travel path, or the curve, so that, from these data, appropriate angle calculations with respect to a vehicle driving ahead, which has been detected by the sensor, can be carried out The bend of a trajectory, in this connection, is looked upon as being the reciprocal value of the radius of the path, (in English: the curvature).

With the aid of adaptive long-term filtering, quality indicators of the trajectory are ascertained from the ascertained misalignment angles of individual trajectories. With the aid of the quality indicators of the trajectory, reliability of the angle measurement is advantageously improved. In this case, for example, the determination of the quality indicators is made from the correlation value of a regression analysis of the curvature, the number of measured values, the length of the trajectory and/or the speed of the object. Since these parameters are relatively simple to measure, this also makes possible a simple calculation of the quality indicator.

For the application of adaptive long-term filtering of the ascertained misalignment angle from individual trajectories, for example, a noise-optimized, linear, adaptive filter (e.g. a Kalman filter) is suitable, or a nonlinear filter in which the weighting of the individual measured values from the quality valuation is based on the quality indicators of the trajectory.

A nonlinear filter can also be used as a suitable adaptive long-term filter, in which the weighting of the individual measured values is done from the quality appraisal.

It is regarded as a special advantage that, with a positioning of the sensor outside the center line of the motor vehicle, the control system ascertains the misalignment angle with respect to the center line of the motor vehicle. That also causes the lateral angle arising from the center displacement of the sensor to be compensated for.

It is also favorable that the ascertainment of the misalignment angle is weighted either as a function of the weighted average values of the yaw rate sensor or of the displacement from the center line. This yields an improvement in the signal quality, which improves the

robustness of the method for determining the misalignment angle, depending on the availability of the individual systems, since almost always at least one of the two methods receives suitable input data. Thereby one method advantageously compensates for the weaknesses of the other method.

By weighting the averaged mean values of the two individual methods, one obtains an improved signal quality.

Brief Description Of The Drawings [of the Drawing

An exemplary embodiment of the present invention is represented in the drawings and explained in detail in the following description.]

Figure 1 shows a first diagram with angle representations of ray paths[,];
Figure 2 shows a block diagram of a distance sensor [and];
Figure 3 shows a second diagram.

Detailed Description [of the Exemplary Embodiment]

Figure 1 shows two motor vehicles 5, 6 which are traveling along on a road one behind the other at a distance d, the assumption being that motor vehicle 5 is behind motor vehicle 6. Furthermore, for reasons of clarity, only the middle rays of a sensor 2 are illustrated, not the entire radiation in the radiation range. It is also assumed in the exemplary embodiment that, in a first embodiment variant, a sensor 2 is mounted centrically on the front face of motor vehicle 5. It is aligned in such a way that its middle ray detects the rear end of motor vehicle 6 driving ahead. On account of an assumed misalignment, the transmitted ray does not hit the rear end along the center line of motor vehicle 5, but rather displaced by an average angle alpha_sensor. For the sake of completeness, let it be mentioned that this reflected ray is received by a corresponding receiving device of sensor 2 and evaluated. Such an evaluation method is known, for example, from German Published Patent Application No. 197 46 524 [A1]. In the exemplary embodiment according to the present invention, the sensor is not positioned centrically but laterally displaced by a distance y_{radar}. With this sensor 2, now, the central ray b hits the projected center line of motor vehicle 5 at the rear end of target object 6

at an angle alpha_vehicle. From this positioning displaced from the center by the distance y_{radar}, and the distance d to vehicle 6 driving ahead, an angle can now be determined according to the equation

$$alpha\_vehicle = alpha\_sensor + y_{radar}/d.$$

This angle alpha_vehicle is ascertained by repeated measurements during the trip and suitable long-term filtering. Using this systematic deviation, the angle measurement of sensor 2 can be corrected.

Carried out principally on a straight stretch of road, this method of compensating the misalignment angle by averaging the current target object angle over a plurality of measurements is less applicable in curves of the road, since there, the target "vehicle 6, driving ahead" is constantly changing the relative vehicle position with respect to sensor 2, because of the radius of curvature. To compensate for the error caused by the radius of curvature of the road, a yaw rate sensor 3 is provided on motor vehicle 5 to detect the change of direction of motor vehicle 5 about its vertical axis. Using the normalized signal from yaw rate sensor 3 and the angle alpha_vehicle, the result is an average deviation of the curvature-corrected angle according to the formula,

$$d_{alpha\_object} = \text{average value}(alpha\_vehicle - d^2 \star \text{yaw rate}/(2 \star \text{vehicle speed})),$$

where d_{alpha_object} corresponds to the corrected angle and the yaw rate corresponds to the signal of yaw rate sensor 3.

The averaging is to be carried out by a long-term low-pass filter. Furthermore, depending on the frequency of the averaging, for the magnitude d_{alpha_object} a quality value q_{object} can be given for the reliability of the angle. Since a curve 11 in a road can be set into a plurality of trajectories, there is a further possibility, when determining the misalignment angle, of applying a regression method known per se, as described, for instance, in European Published Patent Application No. 0 782 008 [A2]. According to the present invention, as shown in Figure 3, in dependence on the distance to a moving, or better still, standing target object 10,

as, for example, a crash barrier part or a post, angles w1 or w2 respectively, depending on position A or B of vehicle 5, are measured in curve 11. From the distance d(ti) or d(tj) at point in time ti (position A) or tj (position B) of vehicle 5, for instance, to standing target 10, a lateral displacement y(ti) or y(tj) can be calculated by simple trigonometrical conversion. In contrast to the known method, this advantageously yields additional measuring points within sensor 2, for travel in a curve. It is therefore proposed by the present invention also to combine this method of regression analysis of trajectories with yaw rate signal 3, in order to compensate for the trajectory curvatures. The measured values thus obtained are averaged by adaptive long-term filtering of the ascertained misalignment angles of single trajectories. A noise-optimized, linear adaptive filter, for example a Kalman filter, can be used as the suitable filter. Alternatively, a nonlinear filter can also be used, in which the weighting of the individual measured value is founded on the quality assessment, which is based on quality indicators of the trajectory. The quality indicators are formed, for instance, from the correlation value of the regression analysis, from the curvature, number of measured points, trajectory length and object speed.

As a result, a sliding long-term filtered misalignment angle d_{alpha_traj} or a quality value q_traj is ascertained for the reliability of the angle, or rather is updated with each analyzed trajectory.

Since this second method also does not always yield suitable trajectories, particularly in heavy columnar traffic, in an alternative solution both approaches are advantageously linked to each other. Depending on the reliability of the individual methods, the weightings of the approaches can be varied statically or dynamically. The linking of the two approaches takes place via a weighted average value of both individual methods. The weights are determined from the quality numbers:

$$d_{alpha} = G1\ (q\_traj)\star d_{alpha\_traj} + G2(q\_obj)\star d_{alpha\_obj}.$$

where G1(q_traj) and G2(q_obj) are the weights from the quality numbers. In this respect, Q_traj and q_obj form the quality numbers Qi.

By the introduction of quality numbers Qi for each method, with a decrease in Qi in case no input variable is available for the method in the current cycle, and an increase in case input

variables are available, a simple possibility of selection was found as to which of the two methods is delivering, at the moment, the more reliable statement concerning the current angle measurement. Besides the improvement of the signal quality by the combination, the robustness of the methods increases also, since almost always at least one of the two methods contains suitable input data, that means, that one method compensates for the weaknesses of the other method.

Figure 2 shows a block diagram of distance sensor 10, in which control system 1 is connected to sensor 2 and yaw rate sensor 3. There is also provided a compensation device for angle measurement 4, in which, among other things, the calculation of the angles, among other things, is carried out. The above-named calculations are preferably made with a program that is run by the microcomputer of control system 1.

Abstract

The present invention proposes a] A distance sensor having a sensor for a motor vehicle in which [means are] an arrangement is provided by which [misalignment] gnment angles and trajectory curvatures can be compensated for during travel not only on a straight road but also along curves. In a sensor [(2)] mounted displaced from the center line of the vehicle, an angle (alpha_sensor) is measured which cuts the projected center line of the motor vehicle [(5)] at the target object, a vehicle [(6)] driving ahead. By the additional use of a yaw rate sensor[(3)], curve curvatures of the road are also compensated for, so that angle and distance measurement can also be made along curves.

[(Figure 1)]

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[10191/1903]

DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE.

Background Information

The present invention starts from a distance sensor for a vehicle having a sensor for transmitting microwaves or light, or for receiving an echo signal reflected by a target object, according to the species of the main claim. In the case of speed regulators having a distance sensor (Adaptive Cruise Control, ACC) adapting travel speed of a motor vehicle to slower vehicles traveling ahead, when these are detected by the distance sensor, is already known. However, the distance sensor has a limited detection range, and thus can only detect such vehicles as are located in the prospective course range of the following vehicle. A misalignment of this detection range, which can occur either during installation on the vehicle or during operation, has the effect, however, that the longitudinal axis of the distance sensor relatively to the nominal alignment (center line of the vehicle) has a systematic angle of deviation. This can have the result that this misalignment, for example, leads to a faulty lane assignment of a detected radar object on the path of motion of the motor vehicle (trajectory), that is, to a vehicle being followed or coming in the opposite direction, and that thereby an undesired reaction of the speed regulator can take place.

A compensating device is known, for example, from German Patent No. 197 46 524 A1, for compensating for the installation tolerances of a distance sensor in a vehicle, in which the installation tolerances of a distance sensor are compensated. Using an electronic evaluation device, current object distances and a current object angle are measured during travel, for detected objects relatively to the vehicle axis. In this connection, the misalignment angle to the current target object is determined by forming an average value of many measurements. It is true, though, that this average value formation functions satisfactorily only if the vehicle can follow the target object, a second vehicle traveling ahead, on a sufficiently long straight

path, so that frequent measurements to the target object can be carried out. In the case of curves in the road or, also, uphill and down dale travel with changing angle of altitude, this method fails.

On the other hand, in the case of the device for calculating and correcting a misalignment angle for a distance sensor according to European Patent No. 0 782 008 A2 the angle of deviation from the center line is described, using a regression method. To do this, the angle is measured in each measurement cycle as a function of the distance from moving, or better still, from fixed radar objects. In particular in dense traffic, however, there are not enough suitable objects within sight range of the sensor, so that not enough measured values are available. Thus, each method has the disadvantage that the availability of measured values depends on the travel situation or the traffic situation, as the case may be.

Summary of the Invention

By comparison, the distance sensor according to the present invention or the speed regulator according to independent Claims 1 and 11, respectively, has the advantage that the reliability of the misalignment identification increases by the combination of a plurality of methods for determing a misalignment angle.

A particular advantage as compared to the known related art is considered also to be that the measurements for the misalignment angle can be carried out, not only on a straight travel path, but also along a curve. More measured values result from this, which, in particular, also favor the formation of the average value.

As a result of the measures specified in the dependent claims, advantageous further refinements and improvements of the method indicated in the main claim are possible. It is especially advantageous that a yaw rate sensor is provided as a further instrument, whose signals can be used for correcting trajectory curves. Since the yaw rate sensor detects the rotary motion of the vehicle about the vertical axis, it thereby also detects, in consideration of the driving speed, the bend in the travel path, or the curve, so that, from these data, appropriate angle calculations with respect to a vehicle driving ahead, which has been detected by the sensor, can be carried out The bend of a trajectory, in this connection, is

looked upon as being the reciprocal value of the radius of the path, (in English: the curvature).

With the aid of adaptive long-term filtering, quality indicators of the trajectory are ascertained from the ascertained misalignment angles of individual trajectories. With the aid of the quality indicators of the trajectory, reliability of the angle measurement is advantageously improved. In this case, for example, the determination of the quality indicators is made from the correlation value of a regression analysis of the curvature, the number of measured values, the length of the trajectory and/or the speed of the object. Since these parameters are relatively simple to measure, this also makes possible a simple calculation of the quality indicator.

For the application of adaptive long-term filtering of the ascertained misalignment angle from individual trajectories, for example, a noise-optimized, linear, adaptive filter (e.g. a Kalman filter) is suitable, or a nonlinear filter in which the weighting of the individual measured values from the quality valuation is based on the quality indicators of the trajectory.

A nonlinear filter can also be used as a suitable adaptive long-term filter, in which the weighting of the individual measured values is done from the quality appraisal.

It is regarded as a special advantage that, with a positioning of the sensor outside the center line of the motor vehicle, the control system ascertains the misalignment angle with respect to the center line of the motor vehicle. That also causes the lateral angle arising from the center displacement of the sensor to be compensated for.

It is also favorable that the ascertainment of the misalignment angle is weighted either as a function of the weighted average values of the yaw rate sensor or of the displacement from the center line. This yields an improvement in the signal quality, which improves the robustness of the method for determining the misalignment angle, depending on the availability of the individual systems, since almost always at least one of the two methods receives suitable input data. Thereby one method advantageously compensates for the weaknesses of the other method.

By weighting the averaged mean values of the two individual methods, one obtains an improved signal quality.

Brief Description of the Drawing

An exemplary embodiment of the present invention is represented in the drawings and explained in detail in the following description.

Figure 1 shows a first diagram with angle representations of ray paths, Figure 2 shows a block diagram of a distance sensor and Figure 3 shows a second diagram.

Description of the Exemplary Embodiment

Figure 1 shows two motor vehicles 5, 6 which are traveling along on a road one behind the other at a distance d, the assumption being that motor vehicle 5 is behind motor vehicle 6. Furthermore, for reasons of clarity, only the middle rays of a sensor 2 are illustrated, not the entire radiation in the radiation range. It is also assumed in the exemplary embodiment that, in a first embodiment variant, a sensor 2 is mounted centrically on the front face of motor vehicle 5. It is aligned in such a way that its middle ray detects the rear end of motor vehicle 6 driving ahead. On account of an assumed misalignment, the transmitted ray does not hit the rear end along the center line of motor vehicle 5, but rather displaced by an average angle alpha_sensor. For the sake of completeness, let it be mentioned that this reflected ray is received by a corresponding receiving device of sensor 2 and evaluated. Such an evaluation method is known, for example, from German Patent No. 197 46 524 A1. In the exemplary embodiment according to the present invention, the sensor is not positioned centrically but laterally displaced by a distance y_{radar}. With this sensor 2, now, the central ray b hits the projected center line of motor vehicle 5 at the rear end of target object 6 at an angle alpha_vehicle. From this positioning displaced from the center by the distance y_{radar}, and the distance d to vehicle 6 driving ahead, an angle can now be determined according to the equation

$$\text{alpha\_vehicle} = \text{alpha\_sensor} + y_{radar}/d.$$

This angle alpha_vehicle is ascertained by repeated measurements during the trip and suitable long-term filtering. Using this systematic deviation, the angle measurement of sensor 2 can be corrected.

Carried out principally on a straight stretch of road, this method of compensating the misalignment angle by averaging the current target object angle over a plurality of measurements is less applicable in curves of the road, since there, the target "vehicle 6, driving ahead" is constantly changing the relative vehicle position with respect to sensor 2, because of the radius of curvature. To compensate for the error caused by the radius of curvature of the road, a yaw rate sensor 3 is provided on motor vehicle 5 to detect the change of direction of motor vehicle 5 about its vertical axis. Using the normalized signal from yaw rate sensor 3 and the angle alpha_vehicle, the result is an average deviation of the curvature-corrected angle according to the formula,

$$d_{alpha\_object} = \text{average value}(\text{alpha\_vehicle} - d^2 \star \text{yaw rate}/(2 \star \text{vehicle speed})),$$

where d_{alpha_object} corresponds to the corrected angle and the yaw rate corresponds to the signal of yaw rate sensor 3.

The averaging is to be carried out by a long-term low-pass filter. Furthermore, depending on the frequency of the averaging, for the magnitude d_{alpha_object} a quality value q_{object} can be given for the reliability of the angle. Since a curve 11 in a road can be set into a plurality of trajectories, there is a further possibility, when determining the misalignment angle, of applying a regression method known per se, as described, for instance, in European Patent No. 0 782 008 A2. According to the present invention, as shown in Figure 3, in dependence on the distance to a moving, or better still, standing target object 10, as, for example, a crash barrier part or a post, angles w1 or w2 respectively, depending on position A or B of vehicle 5, are measured in curve 11. From the distance d(ti) or d(tj) at point in time ti (position A) or tj (position B) of vehicle 5, for instance, to standing target 10, a lateral displacement y(ti) or y(tj) can be calculated by simple trigonometrical conversion. In contrast to the known method, this advantageously yields additional measuring points within sensor 2, for travel in a curve. It is therefore proposed by the present invention also to combine this method of

regression analysis of trajectories with yaw rate signal 3, in order to compensate for the trajectory curvatures. The measured values thus obtained are averaged by adaptive long-term filtering of the ascertained misalignment angles of single trajectories. A noise-optimized, linear adaptive filter, for example a Kalman filter, can be used as the suitable filter. Alternatively, a nonlinear filter can also be used, in which the weighting of the individual measured value is founded on the quality assessment, which is based on quality indicators of the trajectory. The quality indicators are formed, for instance, from the correlation value of the regression analysis, from the curvature, number of measured points, trajectory length and object speed.

As a result, a sliding long-term filtered misalignment angle d_{alpha_traj} or a quality value q_traj is ascertained for the reliability of the angle, or rather is updated with each analyzed trajectory.

Since this second method also does not always yield suitable trajectories, particularly in heavy columnar traffic, in an alternative solution both approaches are advantageously linked to each other. Depending on the reliability of the individual methods, the weightings of the approaches can be varied statically or dynamically. The linking of the two approaches takes place via a weighted average value of both individual methods. The weights are determined from the quality numbers:

$$d_{alpha} = G1\ (q\_traj) \star d_{alpha\_traj} + G2(q\_obj) \star d_{alpha\_obj}.$$

where G1(q_traj) and G2(q_obj) are the weights from the quality numbers. In this respect, Q_traj and q_obj form the quality numbers Qi.

By the introduction of quality numbers Qi for each method, with a decrease in Qi in case no input variable is available for the method in the current cycle, and an increase in case input variables are available, a simple possibility of selection was found as to which of the two methods is delivering, at the moment, the more reliable statement concerning the current angle measurement. Besides the improvement of the signal quality by the combination, the robustness of the methods increases also, since almost always at least one of the two methods contains suitable input data, that means, that one method compensates for the weaknesses of the other method.

Figure 2 shows a block diagram of distance sensor 10, in which control system 1 is connected to sensor 2 and yaw rate sensor 3. There is also provided a compensation device for angle measurement 4, in which, among other things, the calculation of the angles, among other things, is carried out. The above-named calculations are preferably made with a program that is run by the microcomputer of control system 1.

What is claimed is:

1. A distance sensor for a motor vehicle, having a sensor (2) for transmitting microwaves or light, or for receiving an echo signal reflected by a target object, and having a control system (1) which has the means, during travel on a straight road, for ascertaining a misalignment angle (alpha_sensor) of the sensor (2) with respect to the center axis (M) of the motor vehicle (5) from the transmitted and received rays, using an algorithm, and for using it to correct the continuing angle measurement, wherein further means (3) are provided by which compensation for trajectory curvatures can be made during travel along a curve.

2. The distance sensor as recited in Claim 1, wherein the further means (3) are a yaw rate sensor, whose signal can be used for correcting the trajectory curvatures.

3. The distance sensor as recited in Claim 1 or 2, wherein the control system (1) designed for determining a quality indicator (q_traj) of the trajectory from the ascertained misalignment angles of individual trajectories by adaptive long-term filtering.

4. The distance sensor as recited in Claim 3, wherein the quality indicator (q_traj) is calculated, for example, from the correlation value of a regression analysis of the curvature, the number of measured points, the trajectory length and/or the object speed (6).

5. The distance sensor as recited in Claim 3 or 4, wherein the adaptive long-term filter is a noise-optimized linear filter, preferably a Kalman filter.

6. The distance sensor as recited in Claim 3 or 4, wherein the adaptive long-term filter is a nonlinear filter in which the weighting of the individual measured values results from the quality appraisal.

7. The distance sensor as recited in one of the preceding claims, wherein, in case of the positioning of the sensor (2) outside the center line (M) of the motor vehicle (5), the control system (1) ascertains the misalignment angle (alpha_sensor) with respect to the center line (M).

8. The distance sensor as recited in Claim 7, wherein the control system (1) is designed to weight the misalignment angle either as a function of the weighted average values of the yaw rate sensor (3) or the displacement (y_{radar}) of the center line (M).

9. The distance sensor as recited in Claim 8, wherein the weighting takes place on the weighted average values of the two individual methods.

10. The distance sensor as recited in Claim 8 or 9, wherein quality numbers for the misalignment angle are developed from the weighting factors (G1, G2) according to the formula:

$$d_{alpha} = G1(q\_traj) \star d_{alpha\_traj} + G2(q\_obj) \star d_{alpha\_obj}.$$

where d_{alpha} is the currently valid misalignment angle from the center line (M) and G1(q_traj) or G2(q obj) are weighted average values from the values of the yaw rate sensor or the average displacement, (and) d_{alpha_traj} and d_{alpha_obj} are associated angles.

11. A speed regulator having a sensor as recited in one of the preceding claims, wherein the sensor (2) is mounted on the front and/or rear area of a motor vehicle (5).

Abstract

The present invention proposes a distance sensor having a sensor for a motor vehicle in which means are provided by which misalignment angles and trajectory curvatures can be compensated for during travel not only on a straight road but also along curves. In a sensor (2) mounted displaced from the center line of the vehicle, an angle (alpha_sensor) is measured which cuts the projected center line of the motor vehicle (5) at the target object, a vehicle (6) driving ahead. By the additional use of a yaw rate sensor (3), curve curvatures of the road are also compensated for, so that angle and distance measurement can also be made along curves.

(Figure 1)

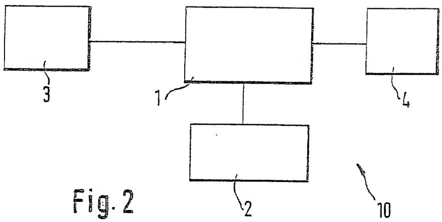

Fig. 2

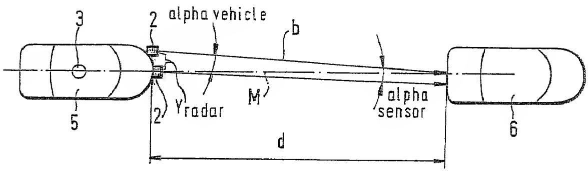

Fig.1

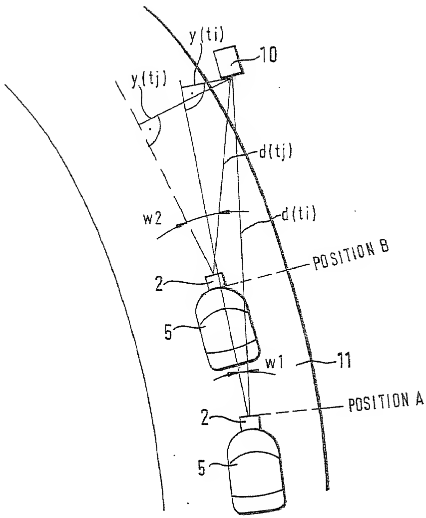

Fig.3

[10191/1903]

COMBINED DECLARATION AND
POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **DISTANCE SENSOR HAVING A COMPENSATION DEVICE FOR A MISALIGNMENT ANGLE IN A VEHICLE**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No.
and,

[X] was filed as PCT International Application Number PCT/DE00/03397, on the 27th day of September, 2000

[X] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

Country : Federal Republic of Germany

Application No. : 199 52 056.9

Date of Filing: 28 October 1999

Priority Claimed
Under 35 U.S.C. § 119 : [x] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR
PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120

U.S. APPLICATIONS

Number :

Filing Date :

PCT APPLICATIONS
DESIGNATING THE U.S.

PCT Number :

PCT Filing Date :

I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.

(List name(s) and registration number(s)):

2

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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